SPE Signals and Setting: Seismic Amplitudes and Velocity Models

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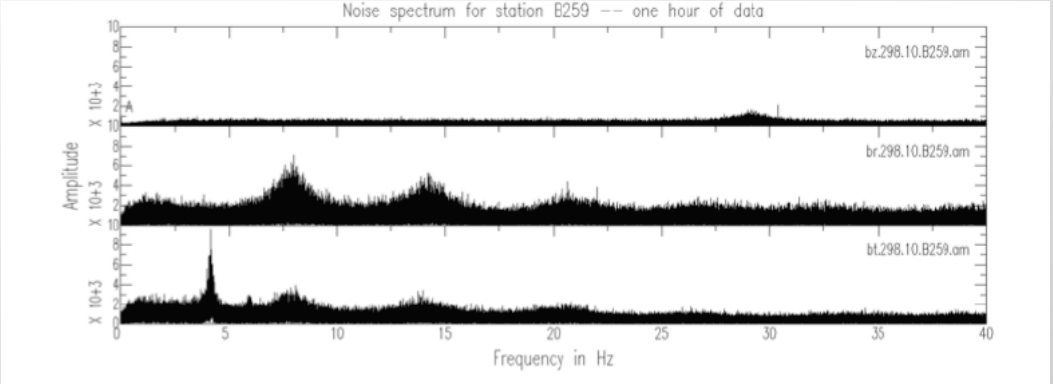
Overview

- EM & Aftershocks
  [*Sweeney et al*., 2013]
- Earthquake/explosion differences
  [*Walter et al*., 2013]
- Velocity models [*Matzel and Mellors*, 2013]
- Next steps

Electromagnetic measurements

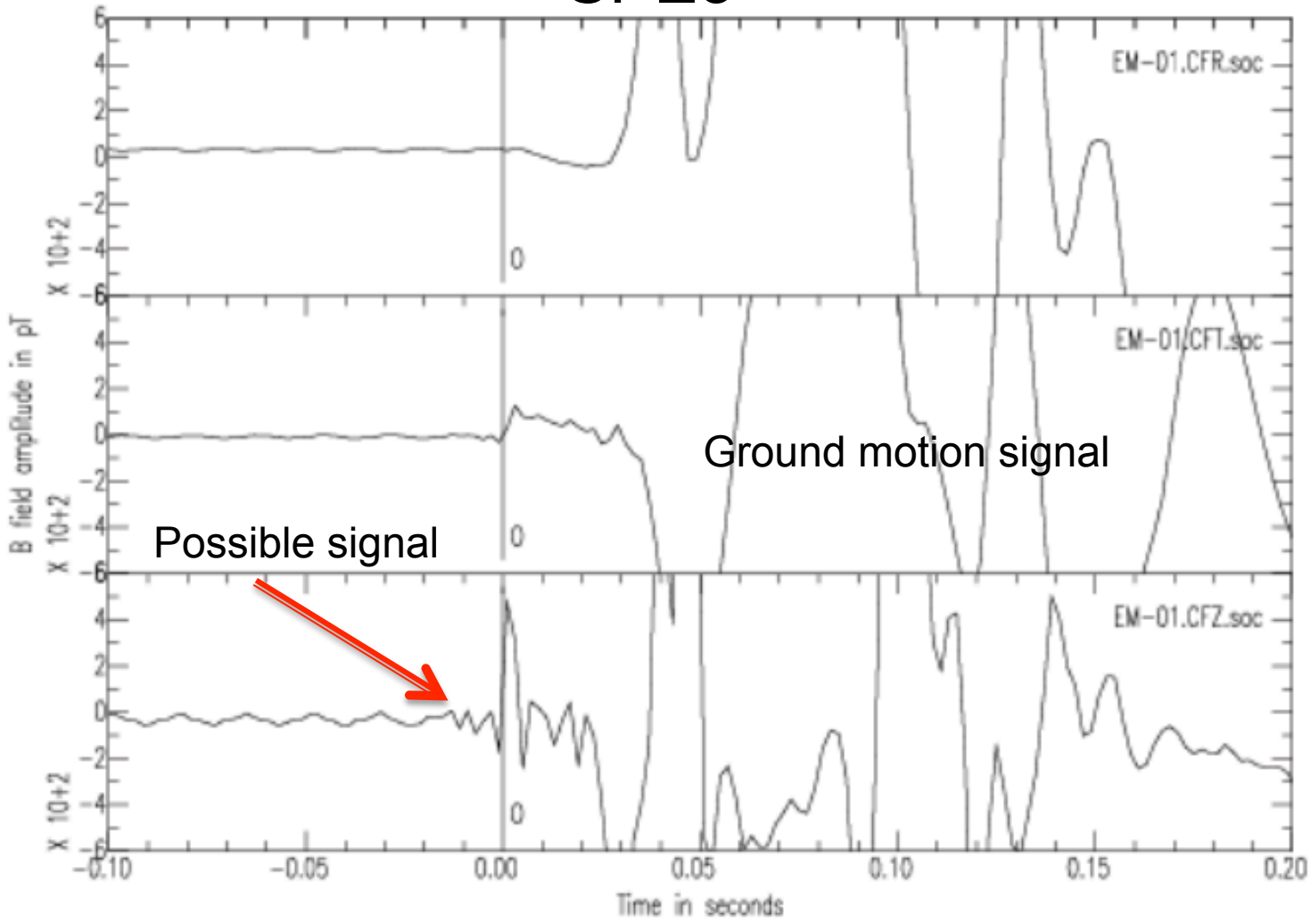


Schumann resonance

Question: Is a low-frequency electromagnetic pulse produced by chemical explosions?

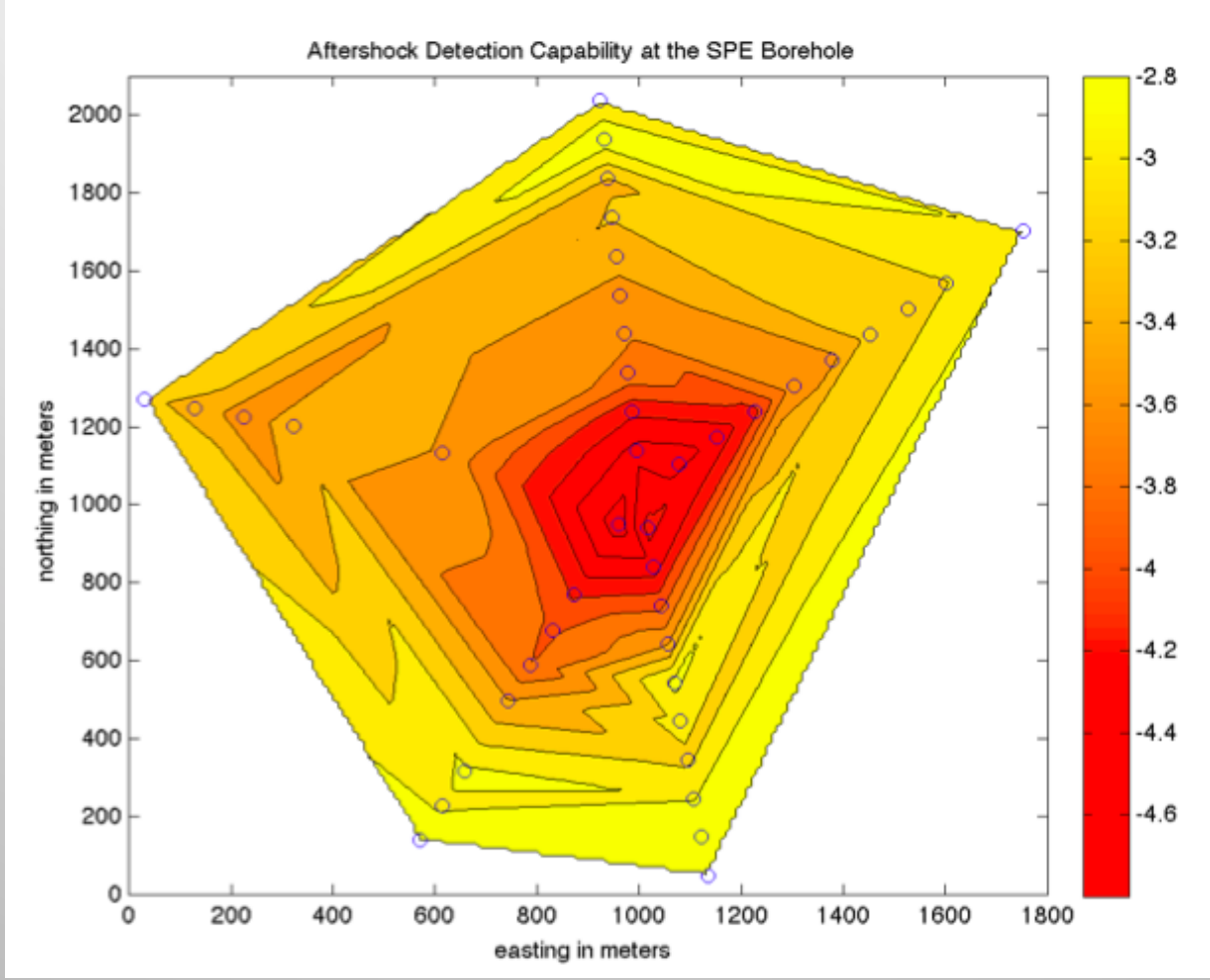
Two three-component magnetometers deployed
[EMI BF-5 magnetometers sampled at 500 Hz; 60 hz notch; measure B field]
SPE2 60 and 90 m
SPE3 25 and 30 m

SPE3



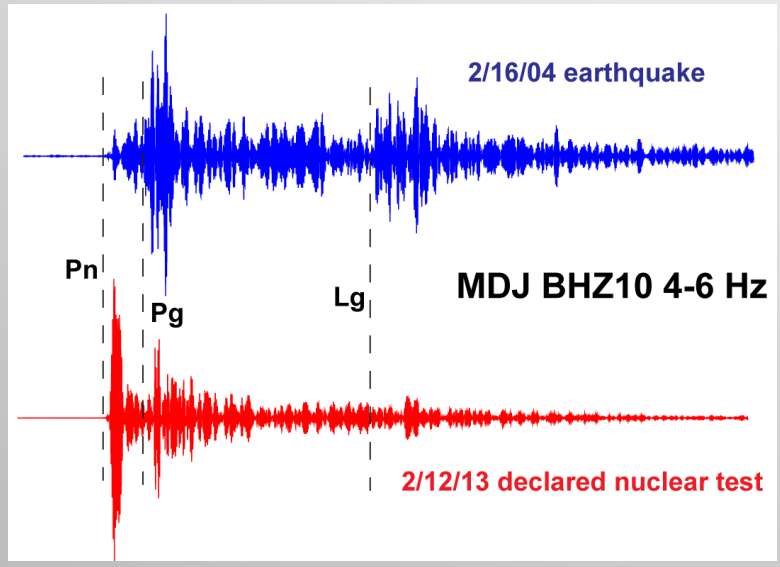
Maybe – SPE 5 and phase II will provide useful constraints

aftershocks

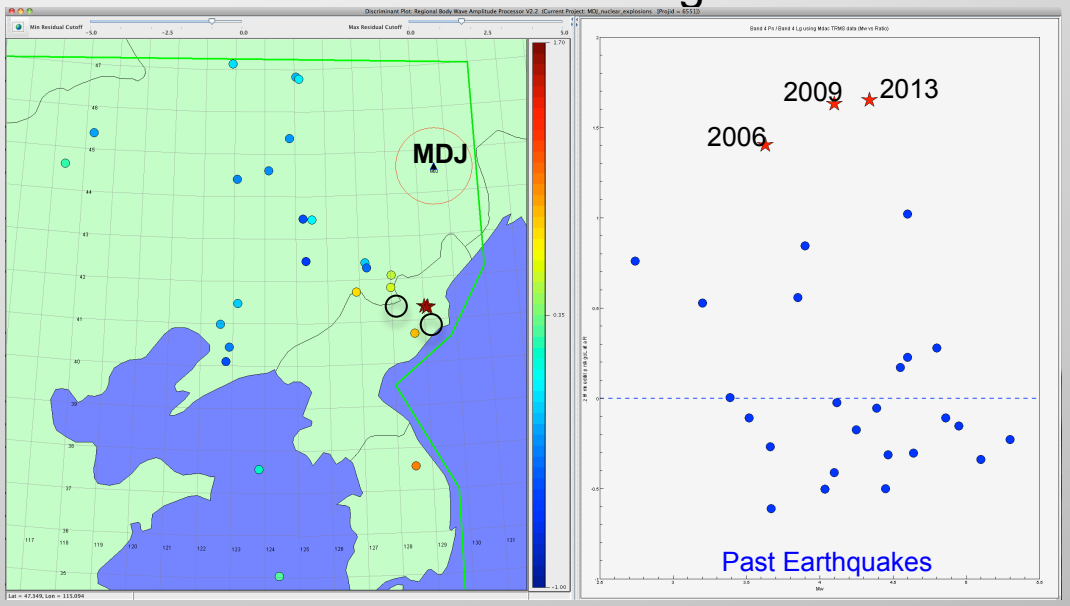


Aftershocks are typical after large underground explosions
None observed for SPE 1, 2, or 3.

Earthquakes and explosions: motivation



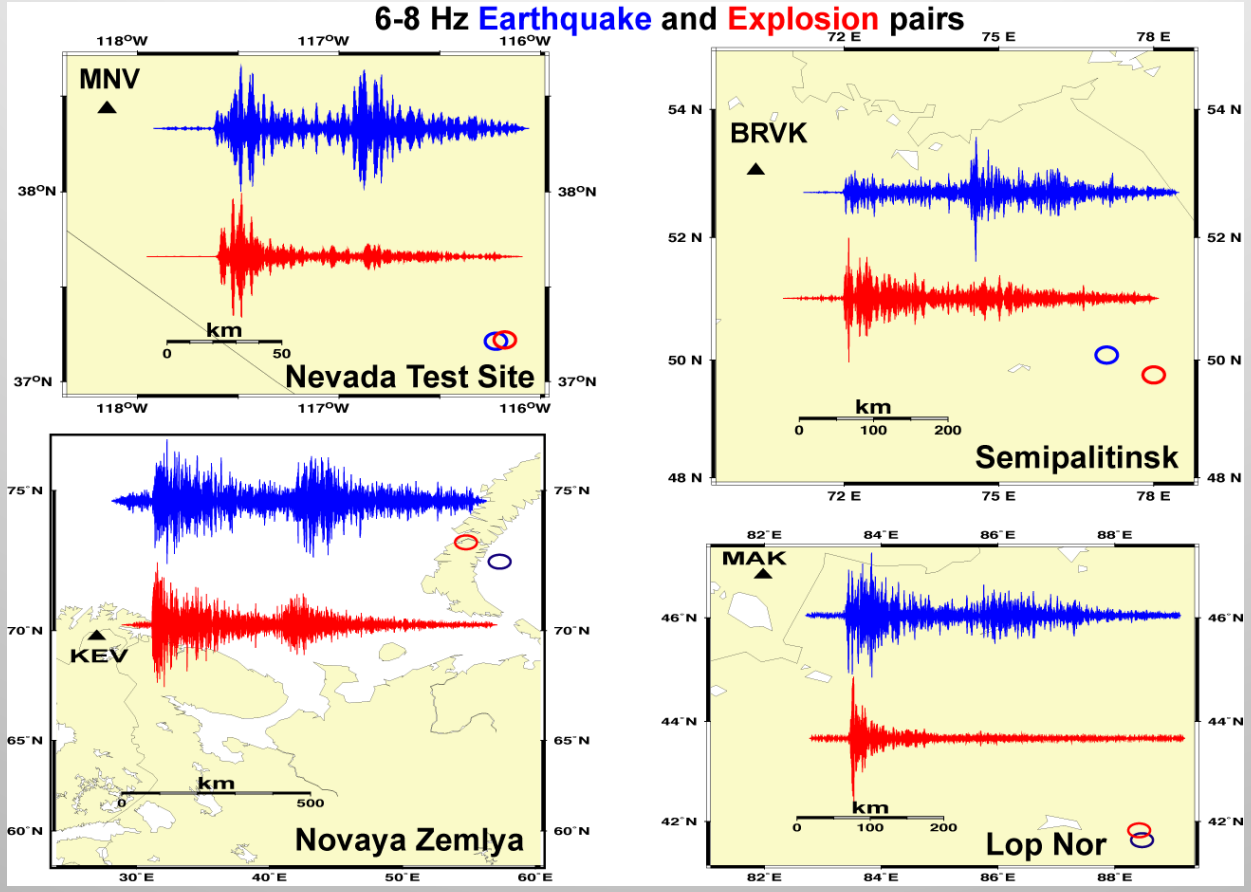
MDAC corrected 4-6 Hz Pn/Lg at MDJ BHZ10



Example of using P and S ratio to discriminate explosions from earthquakes.

Adapted from Walter et al., 2013

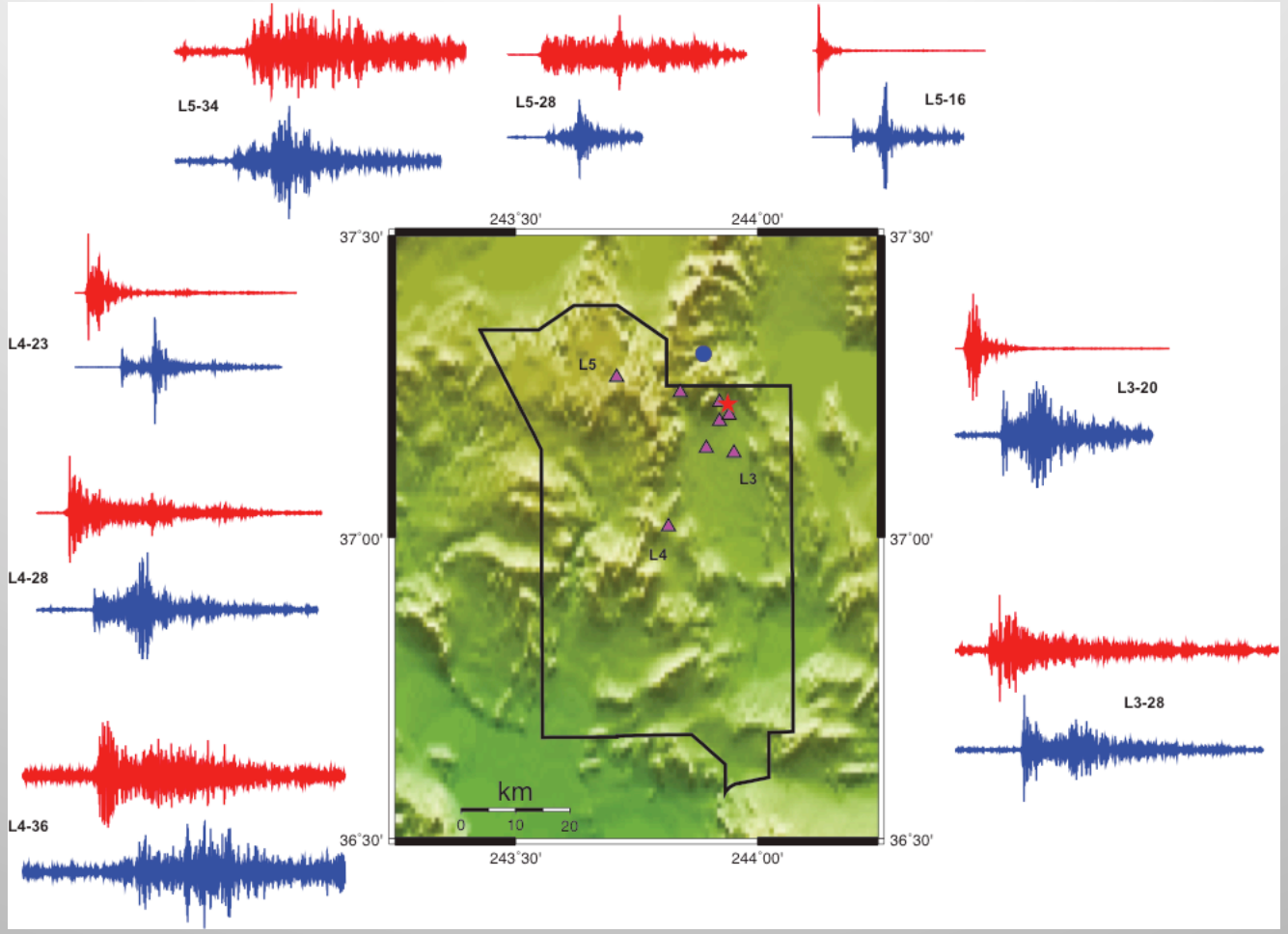
In the 1990's we discovered empirically that high-frequency P/S discriminates explosions from earthquakes at all the major test sites



Can we predict the frequencies where P/S discriminates?
Lower frequencies propagate further extending the range of P/S

From Walter et al., 2013

Discrimination at local/regional distances



SPE: red Earthquake: blue

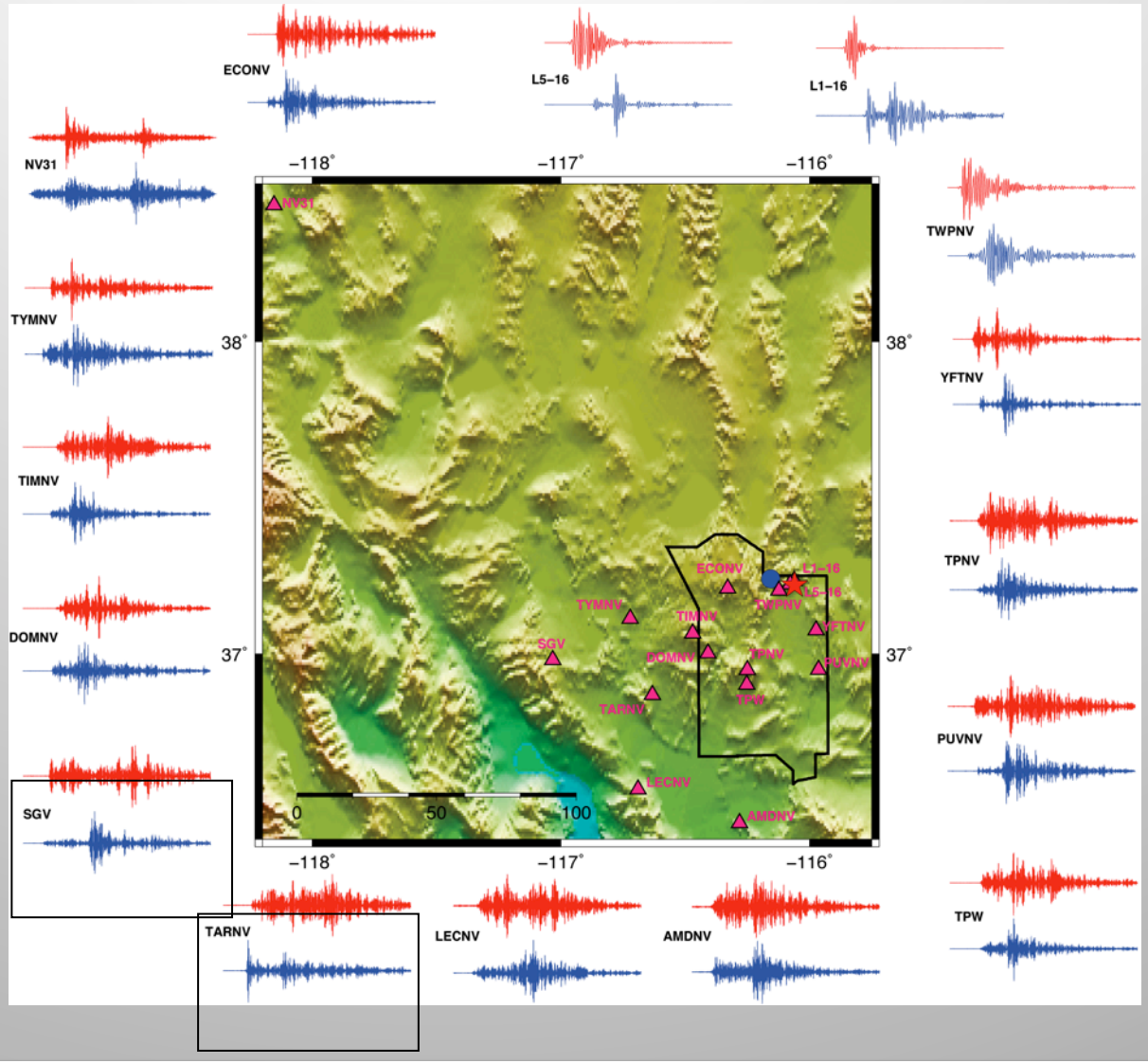
From Walter et al., 2013

Local distance P/S may not discriminate explosions from earthquakes without 3D corrections

Note P/S ratio discriminates SPE from nearby earthquake at regional and some local distances as expected.

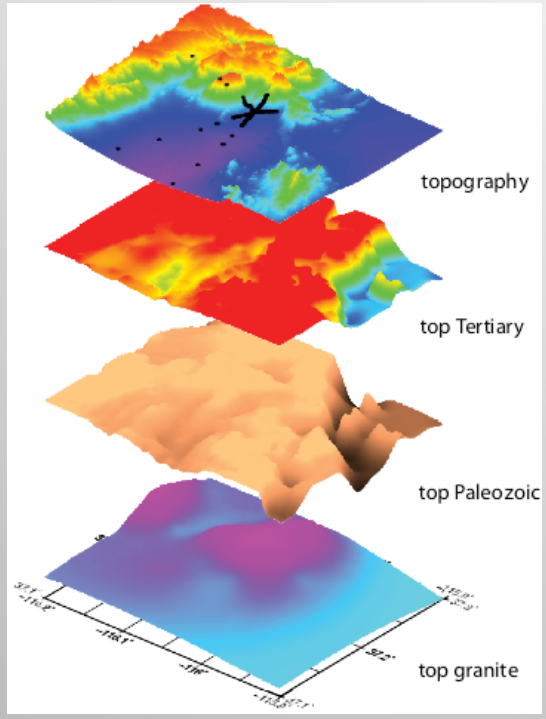
However at SGV compared to TARNV – appears to be a structural focusing/defocusing effect

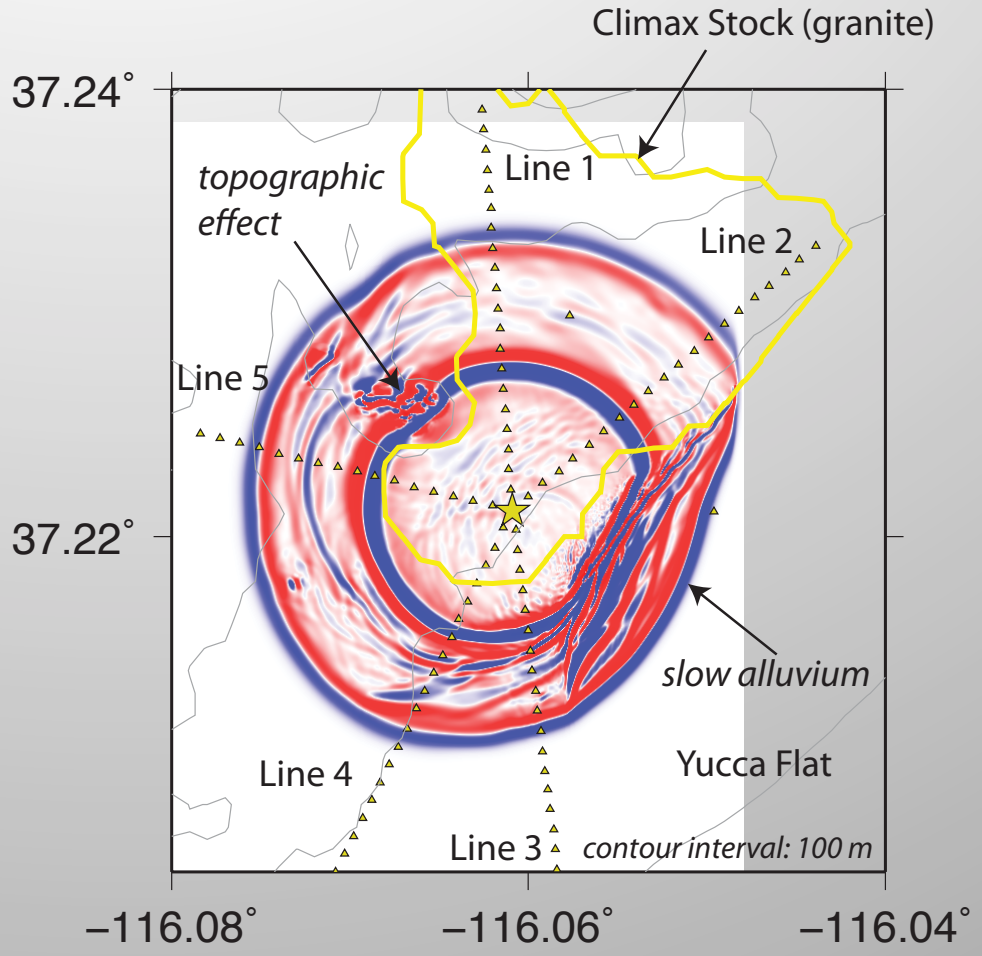
Using Source + Path modeling we will test this hypothesis



From Walter et al., 2013

Path modeling: Need velocity model





3D WPP finite difference simulation
Simple source representation

Question: How good is the model?

Goals:

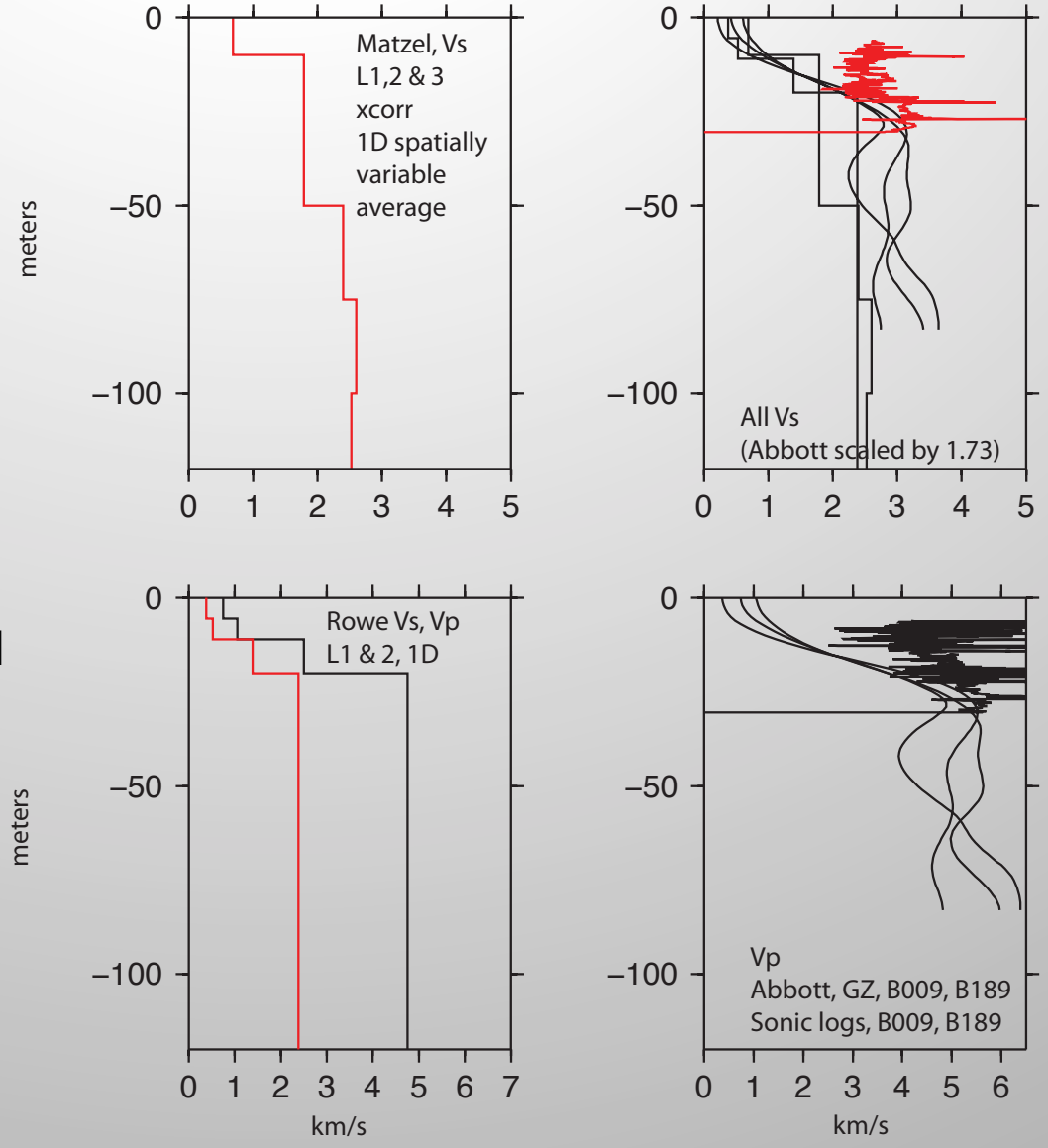
- Improve model
- Site characterization
  - Active source
  - Well logs
- Use seismic data
  - Travel times
  - Surface wave dispersion
  - Inversion
  - Noise/coda correlation

Strategy: start with granite and move outward

Needed:
A standard velocity model

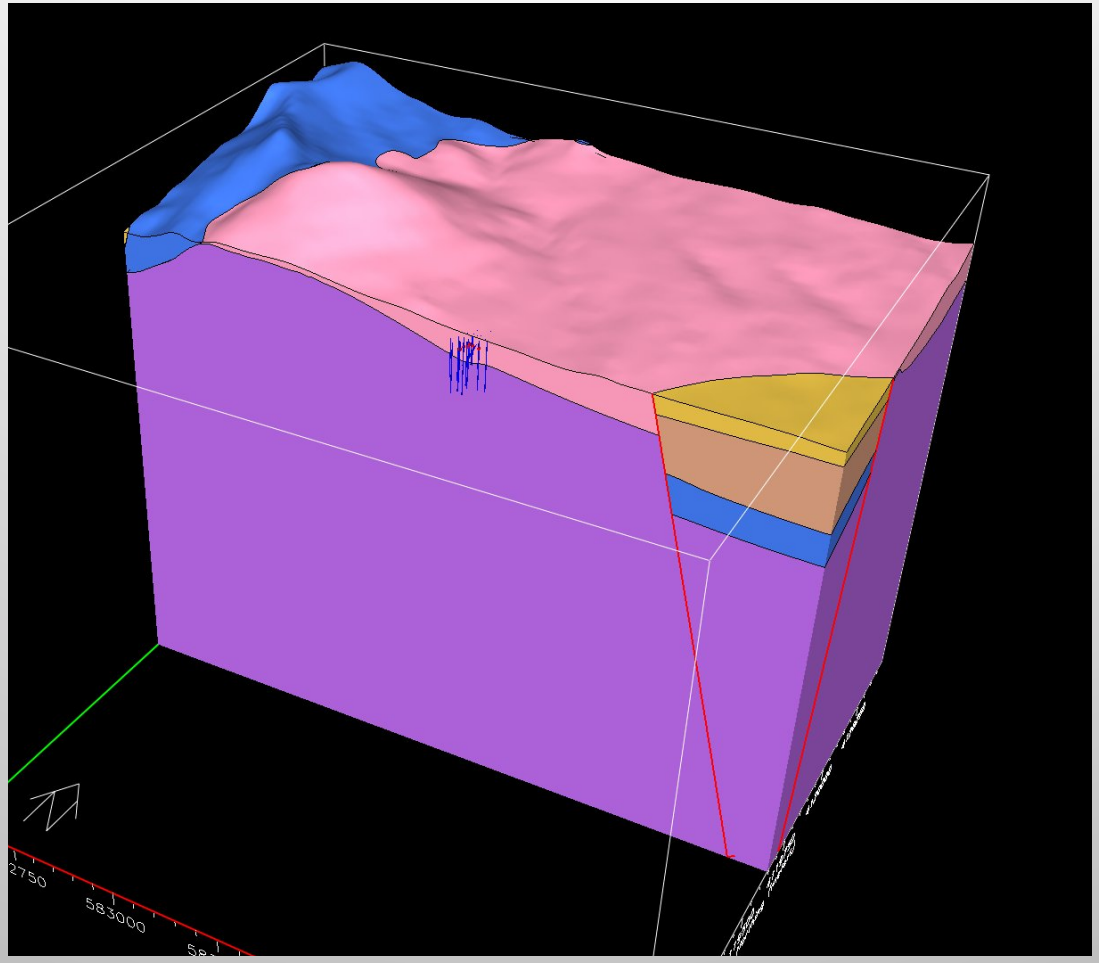
1D representation not good enough.

Climax Stock ‘average’ and near borehole profiles



Thanks to C. Rowe, R. Abbott, M. Townsend

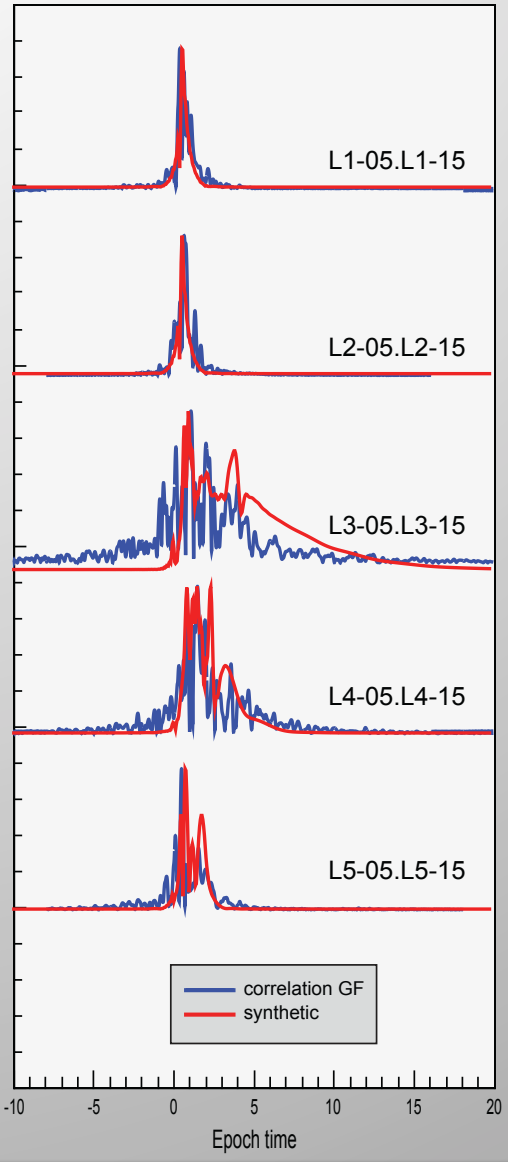
geology



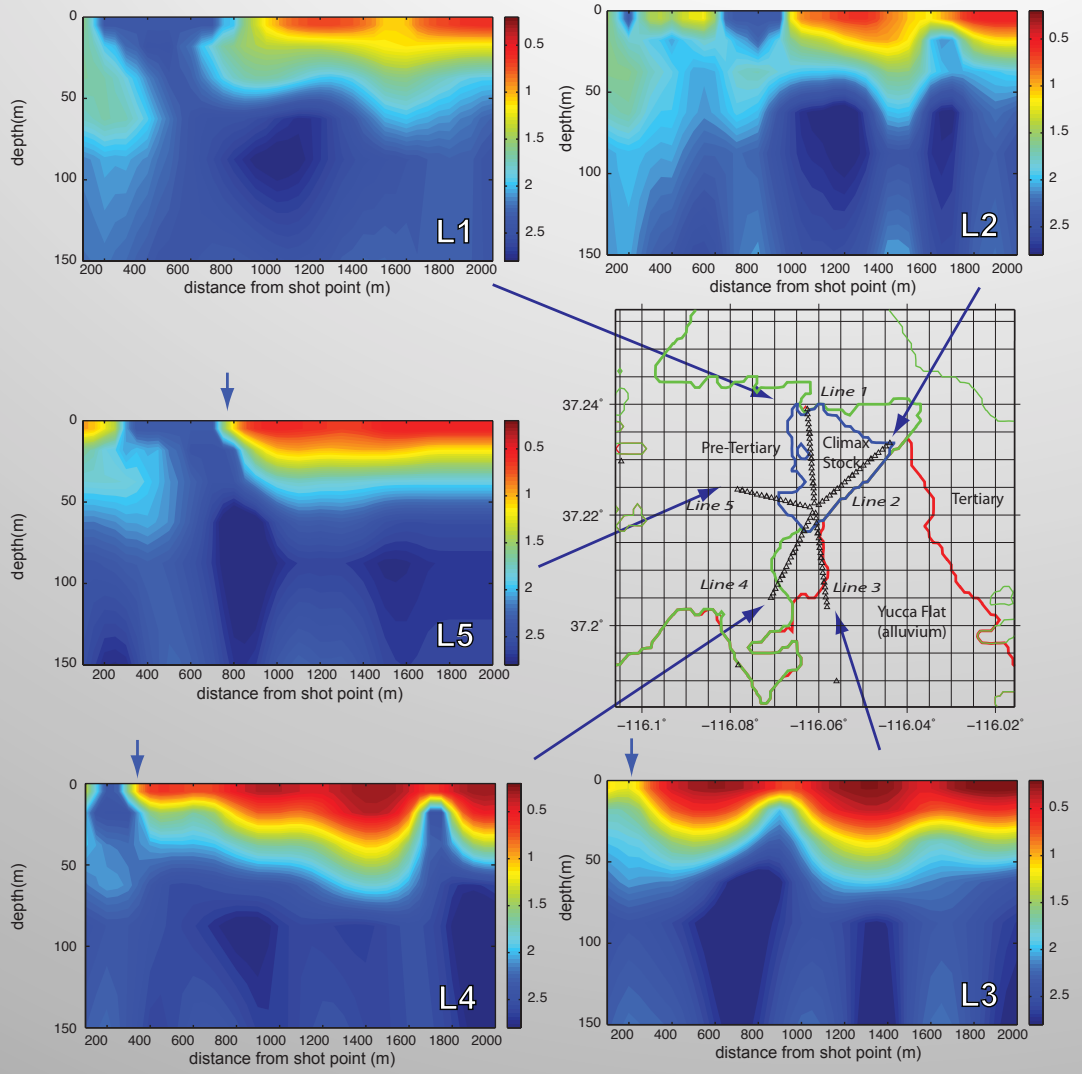
Coda interferometry

- Use shot records from SPE2
- Correlate station with another
- Yields Green's function between stations
- Filter Green's function between 5-10 Hz
- Invert for best-fitting 1D model for each (<5 km) [simulated annealing with FK]
- Combine into 2D profiles along each line

Use absolute value of Green's function



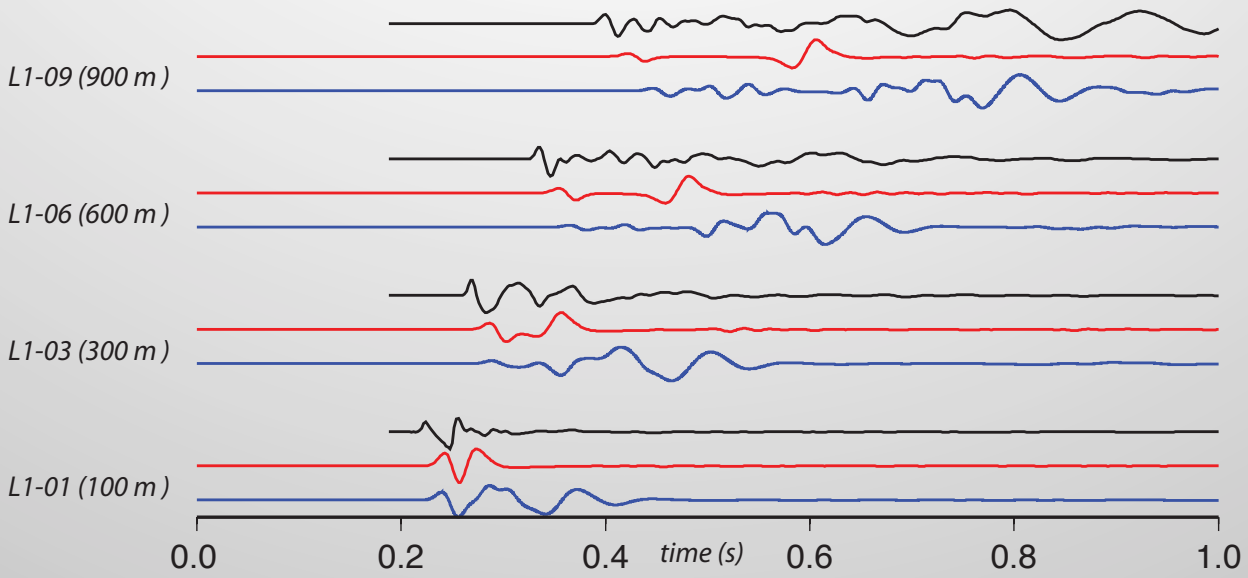
Results



Low velocities along L3, L4
Higher along L1, L2

Velocities at GZ not resolved.

Test model with waveforms

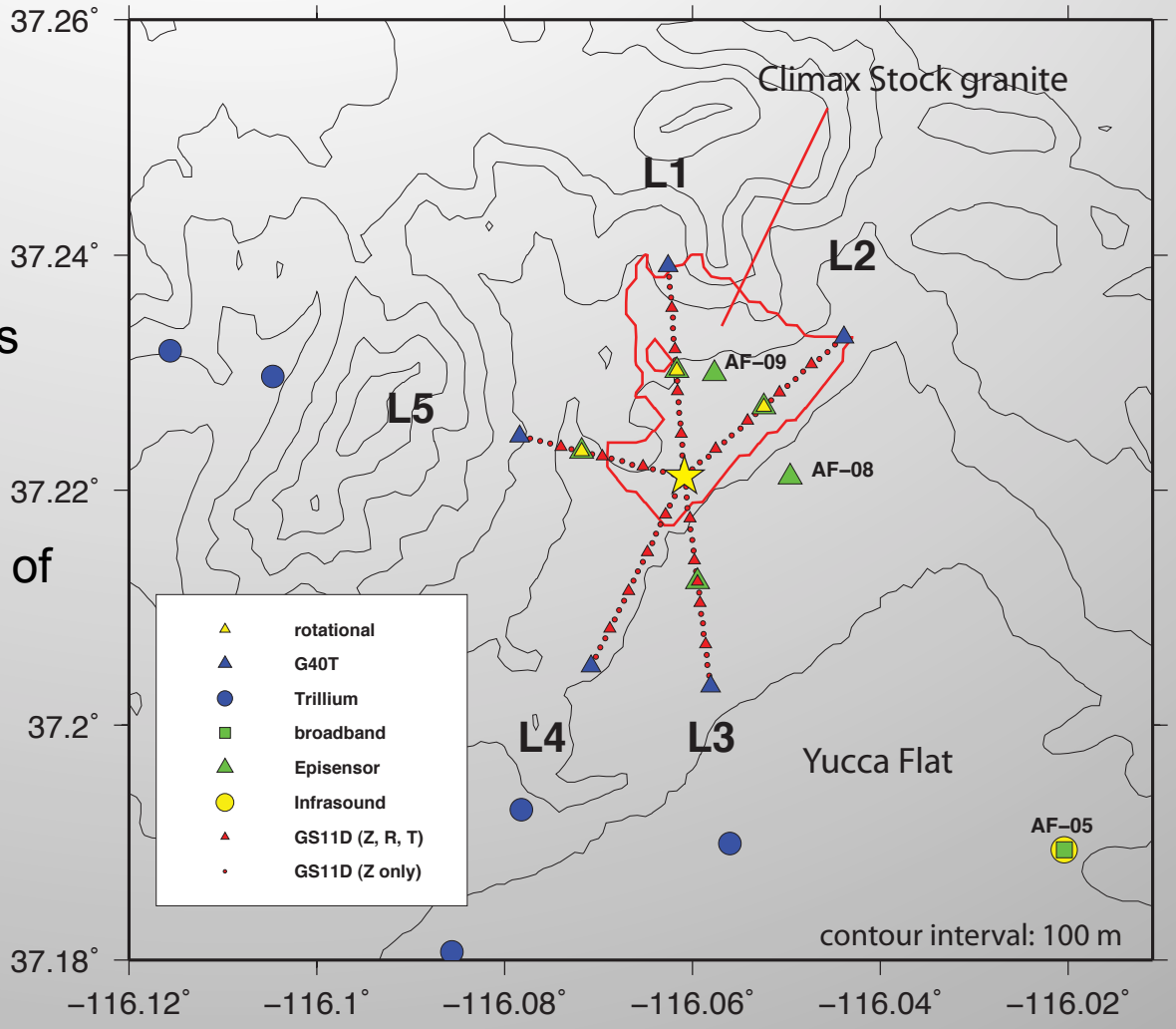


Coda model [2.5 D] travel times delayed w.r.t data
Surface wave generation enhanced.
[geology model here does not include layer]
Need to improve. Use ambient noise.

SPE2 data
geology model
correlation model

Ambient noise correlation

In progress
3 months of high-gain data
All available velocity stations (gs11 and broadbands)
~ 8,000 pairs
Automatically model
Should yield detailed model of region within 2-5 km.



Next steps

- Interferometry appears feasible.
- Ambient noise tomography of all stations (~ 8000 pairs in progress – hope to present at SR/AGU).
- Will yield a 3D velocity model of Climax Stock and northern Yucca Flat.
- Will combine with improved source (e.g. *Vorobiev et al., Pitarka et al.*)
- Should help resolve path effects.